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RICE DISEASES

CONTENTS

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RICE DISEASES

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Southern rice growers lose a substantial part of their crop every year because of rice diseases. In the four leading rice-producing States of the South—Arkansas, Louisiana, Mississippi, and Texas—diseases reduce the average annual yield by about 5 percent. This means an annual loss of more than 100,000 tons of grain. Similar percentages of the annual yield are lost through disease in States that grow rice on smaller acreages, including Missouri, and South Carolina. In California, where much rice is grown, natural conditions are so favorable to this crop that its diseases have been less serious than in the southern rice area.

This bulletin discusses each of the diseases affecting rice in the United States. It tells how losses from these diseases can be reduced through choice of varieties to grow, seed treatment, and methods of growing the crop. At the end of the bulletin, Table 1 lists the scientific names of organisms causing diseases and summarizes the recommended control measures. Table 2 classifies rice varieties with regard to disease resistance and susceptibility.

PRINCIPAL RICE DISEASES

Seedling Blight and Seed Rot

Seedling blight causes stands of rice to be spotty, irregular, and thin from the time they are established. It results from the activities of various kinds of fungi, most of which grow on the kernels or hulls of seed rice or on soil particles. These fungi enter the germinating rice seed or the young seedling and either kill or injure it. If blighted seedlings emerge from the soil at all, they are likely to die soon thereafter. Those that survive are generally weak and yellowish. Figure 1 shows seedlings affected with blight in contrast with one that is normal.

How widespread and severe blight becomes in a field of rice depends chiefly on three things: (1) What percentage of the seed is infected by blight fungi; (2) the soil temperatures; and (3) the soil's moisture content. Seedling blight is more severe on rice that has been seeded early, when the soil was cool and damp. (In Texas and Louisiana, the early seeding season is late February and

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Figure 1.—Three blighted rice seedlings and, at right, a healthy one.

March.) This disadvantage of early seeding can be partly overcome by seeding at a shallow depth. Conditions that tend to delay the seedlings' emergence from the soil often favor seedling blight.

The seeds that carry blight fungi frequently show spots or discolorations on the hulls. However, seed can be infested and still appear to be clean. The fungus that causes brown leaf spot (discussed later) also is one of the chief causes of seedling blight and is seedborne. A seedling attacked by this fungus shows dark areas on the basal parts of the first leaf.

Some blights that affect rice seedlings at the time of germination can be controlled by treating the seed with chemicals. In extensive rice seed treatment tests, several chemicals gave stand increases. In using fungicides, growers should carefully follow the manufacturer's directions regarding quantity to apply, method of application, and safety precautions.

If rice seed is to be sown early in the season, treating it is likely to mean the difference between getting a satisfactory stand from the seeding and having to seed a second time. In experiments, seed treatment has sometimes doubled the density of the stand obtained. Little benefit results from treating rice seed that is to be sown late in the season, unless unfavorable weather conditions prevail at the time of seeding.

One soilborne blight fungus, *Sclerotium rolfsii*, sometimes kills or severely injures large numbers of rice seedlings after they emerge, if the weather at emergence time is moist and warm. A cottony white mold develops on the lower parts of affected plants. This type of blight can be checked by immediately flooding the land. Seed treatment has little or no value for controlling it.

Seedling blight and seed rot of water-seeded rice are caused by some primitive soil fungi known as water molds. The fungi kill the seedling after germination and produce a rusty colored growth on the soil surface immediately around the seed. The fungi differ from those causing seedling blight on drill-seeded rice.

White Tip

White tip is caused by a nematode, or eelworm, which is too small to be seen without a microscope. The tips of the affected leaves turn white and later become frayed and dark colored. Parts of the leaf other than the tip, also, may show light-colored or white areas. The symptoms become most conspicuous, particularly on the flag leaf (the top leaf), just before heading. Often the flag-leaf blade and sheath are twisted so that the head is held within the boot (fig. 2). Severely affected plants have stunted heads that produce little grain, and these grains are abnormal in shape.

The nematodes that cause white tip are carried on the seed. These nematodes do not live in the soil over the winter. Those found on mature rice seed are either on the inner hull surfaces or on the kernel. None get inside the kernel.

The nematodes remain dormant during the months between harvest and seeding. When an infested seed is sown in warm, moist soil the nematodes on it become active, and move into the growing point of the young rice plant. There they feed and rapidly increase in numbers. Their feeding on the young leaf or on the developing head in the boot results in the symptoms described above.

At the heading stage the nematodes establish themselves inside the rice flower, and there they remain during the period of grain formation. As the grain matures, they become inactive. Dormant nematodes may remain viable for 2 years on rough rice in storage.

Commercial rice varieties differ greatly in resistance to white tip. The disease can be controlled simply by growing only varieties known to be resistant. In general, long-grain varieties are resistant and most short-grain or medium-grain varieties are susceptible. Belle Patna, Bluebelle, Starbonnet, and Bluebonnet 50 are resistant long-grain varieties and Saturn is a resistant medium-grain variety.

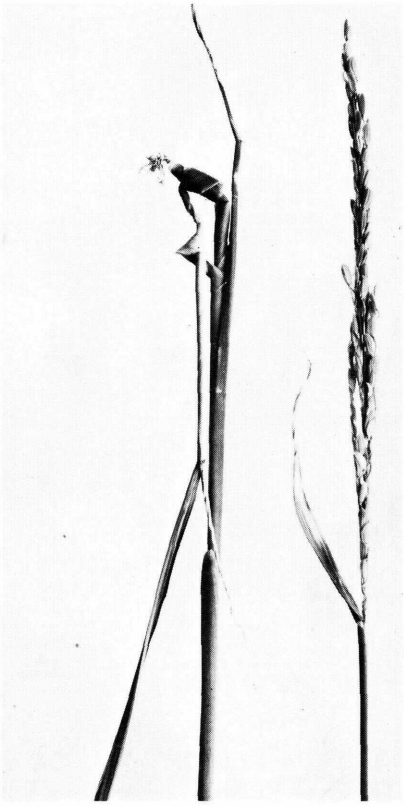

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Figure 2.—Heads of rice plants affected with white tip.

During the growing season the nematodes may be carried by flood water from one field to another. The absence of typical symptoms is a fairly good sign of resistance. Seed of known susceptible varieties that is free of white tip nematodes can be obtained from fields that show no signs of infection.

Treating rice seed to eliminate the white tip nematode has resulted in control of the disease in experiments using hot water and certain chemicals. Such treatments are not practical for use by growers and no treatment is recommended at present for general use. White tip has been controlled in Arkansas by seeding in water and then keeping the field flooded.

Straighthead

In straighthead, rice heads remain upright at maturity because the few grains formed are too light to bend them over in the normal manner (fig. 3). The diseased heads often contain no fertile seed. Usually the hulls are distorted into a crescent or "parrot beak" form (fig. 4). This distor-

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Figure 3.—Straighthead. The rice has matured, but most of the heads contain so few grains that they remain upright.

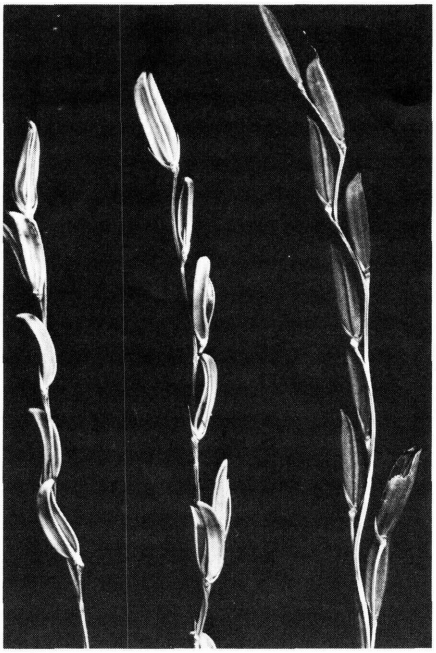

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Figure 4.—Straighthead. The two branches at the left have sterile florets with distorted hulls. The third is normal.

tion is especially conspicuous in the long-grain varieties. One or both of the hulls may be missing. Other parts of the flower, also, are frequently absent. In severe cases, the heads are much smaller than normal and emerge slowly or incompletely from the boot, or the plants practically fail to head. Affected plants continue to grow, remain green, and frequently produce shoots from the lower nodes.

Seed from fields affected by straighthead frequently show a low and abnormal germination, such as two sprouts from one grain.

Apparently straighthead results from some abnormal soil condition that develops around the roots of the rice plant after several weeks' flooding. Straighthead has given trouble frequently on sandy loam soils but seldom on clay soils. In many instances it has occurred when the soil contained too much undecayed plant material from lespedeza or other crops that had been plowed under. On limited areas, it has been caused by arsenic that has accumulated in the soil as a result of repeated applications of arsenic-containing insecticides to cotton.

Generally, straighthead occurs only in spots scattered through a field of rice that is otherwise normal. Losses vary from slight to nearly complete in affected fields.

No variety of rice is immune or even highly resistant to straighthead. Resistant or moderately resistant varieties include Belle Patna, Bluebelle, Bluebonnet 50, and Starbonnet. Nato, Saturn, and Nova 66 are less susceptible than other medium-grain varieties. On land where rice is known to be subject to straighthead, only the more resistant varieties should be sown.

Rice growers in the Gulf States have controlled straighthead in susceptible varieties for many years by draining the fields just before growth reaches the shooting stage. Fields of Dawn should be drained about 52 days after emergence.

Brown Leaf Spot

Brown leaf spot is one of the more prevalent and serious dis-

eases in Texas and Louisiana. The fungus causing it attacks the seedlings and also the leaves and heads of older plants. The fungus is seedborne.

Leaf spot may be evident from shortly after the seedling emerges until the plant matures. Spots are circular to oval (fig. 5) and are of a dark-brown or grayish color. The spots vary in size, color, and appearance according to rice variety. Severe leaf spotting is often shown by plants in dense stands or by other weak plants. On severely affected plants the leaves, or large parts of them, die before maturity and the disease may reduce the yield and the quality of the grain.

Plants thus affected produce lightweight or chalky kernels. Spots very similar to those on the leaves appear on the hulls and persist after the seed matures. Spots or stained areas may occur also on the kernels, reducing the quality of the grain.

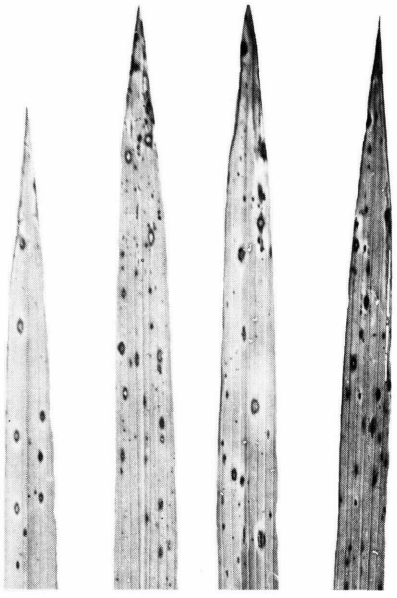

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Figure 5.—Brown leaf spot, one of the most prevalent and serious diseases of rice.

No rice variety is considered highly resistant. Dawn is moderately resistant and Vista is resistant.

Damage from brown spot can be lessened by maintaining good growing conditions for rice through—

- Balanced fertilizing.
- Crop rotation.
- Land leveling.
- Soil preparation.
- Cultural practices.

Seed treatments reduce the severity of seedling blight caused by this seedborne fungus.

Blast

Blast (also called rotten neck and pyricularia blight), in the southern rice States has caused serious losses.

Blast is a fungus-caused rice disease in which spots appear on the leaves (fig. 6) and blighting of the leaves or of the whole plant follows. Rice plants probably are most susceptible to leaf attack before irrigation begins and at the tillering stage. The spots on young leaves are generally long, rather narrow, and brown with a grayish center. They resemble those of the brown leaf spot disease, and sometimes it is hard to tell the two kinds apart except by using a microscope. Blast differs from brown leaf spot, however, in that it causes longer

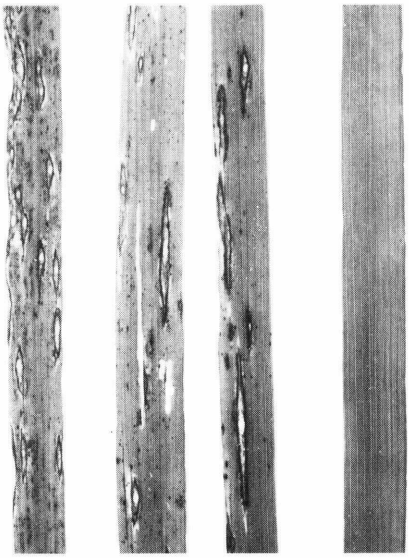

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Figure 6.—The long, narrow spots on these rice leaves are typical of the fungus-caused disease known as blast. At right, a normal leaf.

spots, develops more rapidly, and blights the leaves. In severe cases, the plant is stunted and loses nearly all its leaves or the whole plant (including the tillers) is killed.

The blast fungus frequently attacks the neck, blighting the head. Frequently, also, it attacks branches of the head. The name "rotten neck" is applied to breaking over the head at the affected neck region. In addition the fungus attacks the nodes (joints) of the stem, with the result that they turn dark and the part of the stem above the point of attack is killed. Infection may appear also at the place where the leaf blade joins the sheath.

Blast has occurred in a scattered rather than a widespread way, and less frequently than the brown leaf spot. It has often been severe on newly cleared land and on land cropped to rice for the first time in several years. Perhaps this is explained by the fact that the soils of such areas are likely to contain much nitrogen, for rice is more susceptible to blast on soils having a high nitrogen content. High nitrogen fertilization should be avoided on rice soils of this kind.

Rain and warm weather favor development of blast. This is illustrated by the fact that outbreaks of blast in Louisiana in recent years have been confined to rice sown in June in most cases.

When young plants are attacked, development of the disease can be slowed down by flooding the field.

A variety that appears to be resistant to the blast fungus is sometimes found not to resist all its different races. Vista, Saturn, Nova 66, and Dawn are resistant to the common or prevalent races. The fungus is sometimes seedborne.

Stem Rot

Stem rot, caused by a fungus that lives in the soil, is one of the more important rice diseases in Arkansas, Louisiana, and Texas, and it frequently causes losses in California.

The first symptom is the appearance of irregular-shaped watersoaked areas on the sheaths, at or slightly above the waterline. Gradually these areas turn black

and become larger, and in the course of time the infection enters the stalks. At this stage dark masses of fungus growth develop, together with black or dark-brown streaks along the stalk. At more advanced stages, splitting the stalk reveals a cottony grayish mold inside.

Later, when the rice is generally approaching maturity, many small, black seedlike bodies, called sclerotia, can be seen within split stalks (fig. 8) and in the rotting sheaths. At this stage the stalks break over and the plants lodge. Plants that are attacked early and killed before they mature produce lightweight grain or almost no grain. Lodging resulting from stem rot often makes harvesting difficult. (Not all lodging of rice is due to stem rot.)

The fungus causing stem rot often develops abundantly in rice stubble after harvest, even if little stem rot was present when the crop matured. The fungus lives in the soil and stubble in the form of sclerotia and may remain alive in the soil for 6 years. Certain wild grasses are susceptible to stem rot, and the infection may spread from them to rice.

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Figure 7.—Narrow brown leaf spot, perhaps the most prevalent disease of rice in the Gulf States.

None of the commercial varieties of rice are highly resistant to stem rot. Rexoro is somewhat more susceptible than other varieties. Because stem rot generally does not become prevalent until August or September, early maturing varieties, like Belle Patna and Bluebelle, tend to escape serious damage if sown early.

Treating the soil with chemicals that kill the fungi and nematodes has increased rice yields considerably in tests made in Texas and Louisiana. None of the chemical soil treatments tested are recommended to rice growers however, because of their high cost. Treating rice seed with chemicals as described under the heading "Seedling Blight and Seed Rot" may prevent root rot and decay at the bases of the stems of young plants. Top-dressing a rice field with fertilizer containing nitrogen and phosphate, and in some cases with zinc, reduces root rot and improves yields in alkali spots.

Losses from root disorders can be held to a minimum through fertilizing and cultural methods that serve to maintain rice plants in a vigorous condition. A good way to stimulate new root growth and control rice water weevils is to drain the field and let the soil dry.

Tests and observations made in Arkansas showed that application of potassium fertilizers to the soil reduced the severity of stem rot. Another control measure is to drain the water from the field at an early stage of sheath infection and keep the soil saturated, but not covered, with water until the rice has almost matured. Although the fungus can live in the soil for several years, crop rotations undoubtedly have considerable value for controlling it.

Use of fertilizers containing nitrogen makes the plants more susceptible.

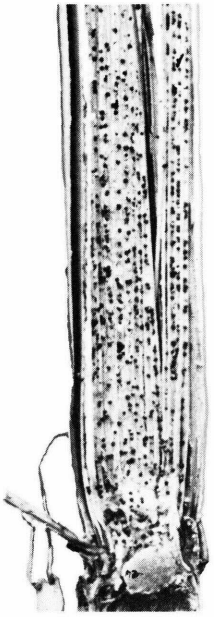

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Figure 8.—Stem rot. Splitting of a rice stalk has revealed black fungus bodies inside. (About 3 times natural size.)

Root Rot

Root rot, as discussed here, includes several diseases or disorders in which the roots of young rice plants become deformed and discolored, then decay (fig. 9). As root decay progresses, the leaves cease to grow normally and turn yellow. The affected plants may die at any stage of growth.

Root rot may be caused by any one of several fungi. Rice roots may be damaged, also, by the feeding of nematodes and of rice water weevils. Plants growing in saline or alkali spots generally are affected with root rot and as a result grow poorly.

Brown-bordered Leaf and Sheath Spot

Brown-bordered leaf and sheath spot is frequently an important disease of rice in the Gulf States. Large spots appear on the sheaths just above the water line (fig. 10). The spots have irregular outlines and reddish-brown borders. The fungus also may kill the leaves and cause lodging in limited areas of the field. It favors warm, moist weather. Generally the plants attacked are in thick stands that retain moisture a large part of the day and are in the late tillering or heading stage.

This disease is caused by a soil fungus. Sclerotia are formed on diseased plants. Various wild grasses growing in mixture with rice may serve as sources of infection. A diseased grass plant is often found at the center of heavily damaged spots.

Rice varieties that possess a degree of field resistance include several medium-grain varieties

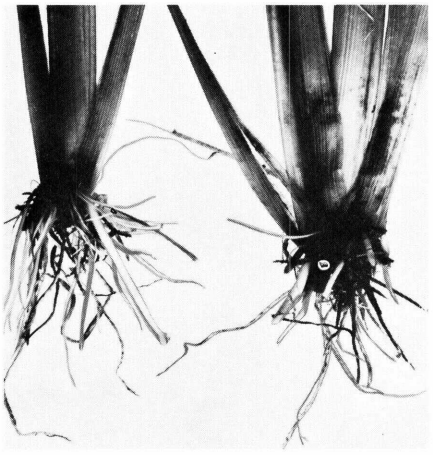

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Figure 9.—Root rot.

(Arkrose, Gulfrose, Nato, and Nova 66) and a few short-grain varieties (Asahi, Caloro, and Colusa). Susceptible varieties include Belle Patna, Bluebelle, Bluebonnet 50, Dawn, and Starbonnet among the long-grain varieties, and two medium-grain varieties, Northrose and Saturn.

Damage from this disease is decreased when: (1) foliage density and lodging of plants are kept to a minimum by avoiding excessive seeding rates and using proper timing of nitrogen topdress applications; and when (2) grass and other weeds are well controlled.

Kernel Smut

Kernel smut, another fungus disease of rice that has caused losses in the South, can be detected only on heads that have almost matured. At that stage a part or all of the starchy material of each affected kernel has been replaced by a black mass of smut spores. Release of some of the smut spores from within causes discoloration of the hulls (fig. 12). Generally, only 1 to 8 smutted kernels are found on a head.

The smut is detected most easily after rain or in early morning after a heavy dew. Moisture causes the dark mass of spores to swell and break out between or through the hulls. Spores that have not yet broken out can be seen through the wet hulls.

Kernel smut does not destroy the rice embryo, and the diseased seed generally germinates even if all the endosperm has been replaced by smut spores.

High rates of nitrogen fertilizer increase the incidence of smut. Varieties of rice seem to differ in susceptibility. The medium-grain varieties, except Nato, show less smut. Among the present varieties, Dawn, Bluebonnet 50, and

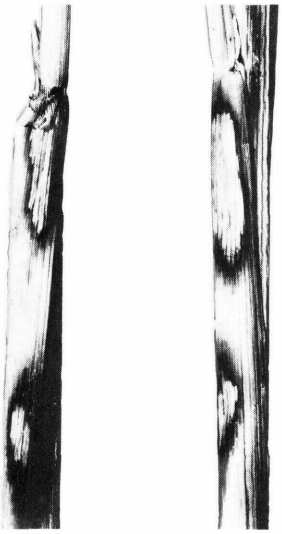

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Figure 10.—Brown-bordered leaf and sheath spot.

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Figure 11.—Leaf smut.

Rexoro are the most susceptible. Early maturity varieties generally show little smut, if sown early.

MINOR RICE DISEASES

Narrow Brown Leaf Spot

Narrow brown leaf spot, sometimes known as cercospora leaf spot, is perhaps the most prevalent disease of rice in the Gulf States. This disease varies in severity from year to year. Generally it becomes more severe as the rice approaches maturity.

The leaf spots are long and narrow (fig. 7) and of a light-brown or brown color. In severe cases the leaves die, one after another, until hardly any remain.

Infection does not become very severe until late August or September. Therefore, early maturing varieties like Belle Patna and Bluebelle, tend to escape heavy infection if they are sown early.

Marked differences in susceptibility have been found among rice varieties. However, some of the different races of the fungus causing this disease may damage certain rice varieties that are resistant to other races. Because the prevalence of individual races varies from year to year in relation to that of other races, a rice variety may show resistance to narrow brown leaf spot in a certain place for several years and then succumb to it. Bluebonnet 50 and Rexoro are more susceptible than Nato, Saturn, Nova 66, Belle Patna, and Bluebelle.

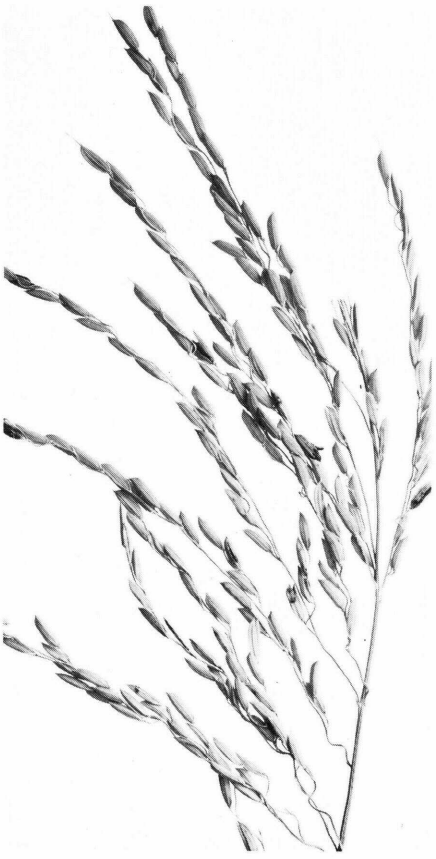

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Figure 12.—Kernel smut. Release of smut spores from affected kernels discolors the hulls and the milled rice.

Leaf Smut

Leaf smut (fig. 11) is a minor fungus disease of rice in which small, slightly raised black spots, called sori, develop on the leaves and, to a lesser extent, on the sheaths and stalks. These spots contain the black spors of the smut fungus. Often infection is heavy enough to kill the tips of the leaves. When the spores have matured, the sori break open and liberate them. Leaf smut appears rather late in August or in September. No control measures are warranted.

Kernel Spots

Several types of kernel spots are found on rice. Several fungi cause rice kernels to be spotted, stained, or otherwise imperfect. Generally the same fungi cause heavy spotting or discoloration of the hulls. Kernel spotting appears to increase in damp or rainy warm weather and in rice that matures late in the season. Punctures of the developing kernel by the rice stink bug, plus growth of fungi in the injured areas, result in a type of kernel spot called pecky rice.

The presence of spotted or stained kernels reduces the grade of rice. Also, kernels that are severely spotted and therefore chalky break into pieces in the milling process; thus, kernel spot reduces yield of head rice. At present no control method can be recommended, except through insect control.

Hoja Blanca

Hoja blanca, a rice disease caused by a virus that is spread by a plant hopper has not caused losses in the United States. The disease was found in Florida in 1957 for the first time in the United States. Later, in 1958 and 1959, respectively, it was found in south Mississippi and in Louisiana, but it has not been reported in the United States since then. Heavy losses have resulted from this disease in Cuba, Venezuela, and other countries of Latin America.

The first symptom of hoja blanca is appearance of one or more white stripes on a leaf blade, or whitening of an entire leaf blade, or mottling of a leaf in a typical mosaic pattern. The diseased plants do not make normal height growth. Their panicles (heads) fail to reach normal size and often remain partly inside the sheath.

The hulls that enclose stamens and pistil turn brown and rapidly dry out. Often they become distorted. The flower parts are sterile or often even absent. Because the diseased plant produces few seeds or none, its head remains upright instead of bending over at maturity.

Rice plants do not die as a result of hoja blanca. Normal tillers and diseased one may be produced by the same plant. Often the second-crop tillers of an infected plant show no symptoms.

Arkrose, Nova 66, Gulfrose, Colusa, and a few minor rice varieties are resistant.

TABLE 1.—Rice diseases, the organisms that cause them, and control measures

Disease	Casual organism	Control measures
Principal diseases:		
Blast	*Pyricularia oryzae* Cav.	Resistant varieties, early seeding, flooding.
Brown-bordered leaf and sheath spot	*Rhizoctonia oryzae* Ryker & Gooch	Resistant varieties, timing of nitrogen and grass
Brown leaf spot	*Helminthosporium oryzae* Van Breda de Haan.	Seed treatment, cultural practices.
Kernel smut	*Neovossia barclayana* Brefeld	Resistant varieties and nitrogen fertilization.
Root rot	Various fungi including *Rhizoctonia solani* Kuhn and species of *Pythium* and *Fusarium*. Nematodes including a *Meloidogyne* species, *Tylenchorhynchus martini Fielding*, and *Hirchmanniella oryzae* (B. de Haan) Luc et Goodey. Root weevils, *Lissorhoptrus oryzophilus* Kushel.	Crop rotation, balanced fertilizing, other cultural practices, draining.
Seedling blight	Drill-seeded: Chiefly *Helminthosporium oryzae* Van Breda de Hann, species of *Pythium, Rhizoctonia solani* Kuhn, species of *Fusarium, Sclerotium rolfsii* Sacc. Water-seeded: *Achyla sp.* and *Pythium* sp.	Seed treatment, shallow seeding if seeding is done in early spring, flooding.
Stem rot	*Sclerotium oryzae* Catt.	Resistant varieties, balanced fertilizing, draining, crop rotation.
Straighthead	----------	Resistant varieties, draining.
White tip	*Aphelenchoides besseyi* Christie.	Resistant varieties, disease-free seed, water seeding and continuous flooding.
Minor diseases:		
Hoja blanca	[1] ----------	Resistant varieties.
Kernel spots	Various fungi. Rice stink bug (*Oebalus pugnax* (Fabricius)	None except insect control.
Leaf smut	*Entyloma oryzae* H. & P. Syd.	None.
Narrow brown leaf spot	*Cersosopora oryzae* I. Miyake	Resistant varieties, early maturing varieties.

[1] Hoja blanca is caused by a virus that is transmitted by a plant hopper, *Sogatodes oryzicola* (Muir).

TABLE 2.—Disease resistance and susceptibility of common commercial rice varieties[1]

Variety	C.I. No.	White tip	Straight-head	Brown leaf spot	Narrow brown leaf spot	Hoja blanca	Blast
Arkrose	8310	VS	S	S	S	MR	S
Belle Patna	9433	R	R	S	S	S	S
Bluebelle	9544	R	R	S	S	S	S
Bluebonnet 50	8990	R	R	S	VS	S	S
Caloro	1561–1	S	S	S	S	S	S
Calrose	8998	S	S	S	S	S	S
Cody	8642	S	S	S	MS	S	S
Colusa	1600	S	S	S	MS	R	S
Dawn	9534	R	VS	MR	MS	S	R
Della	9483	R	S	MS	S	S	S
Gulfrose	9416	S	S	S	MS	R	S
Nato	8998	S	S	S	MS	S	S
Nova 66	9481	S	S	S	MS	R	R
Saturn	9542	R	S	S	MS	S	R
Starbonnet	9584	R	MR	S	S	S	S
Rexoro	1779	R	VS	S	VS	S	S
Texas Patna	8321	R	R	S	VS	S	S
Vista	9628–2	—	S	R	MS	—	R

[1] Key to symbols: R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; VS = very susceptible.

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